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FUTURE PROSPECTS OF THE RAILROAD CAUSE.

The present period is one of remarkable interest in the history of railroads. While the price of stocks of all kinds is at the lowest ebb, while all kinds of investments are looked upon with suspicion, and while the money market is, technically speaking, excessively "tight," we find three of the greatest commercial cities in the Union completely immersed in the discussion of the railroad system, and that not for a few days only, but for weeks and months together.

In Boston, the rejoicings, upon opening an uninterrupted line of railroad communication with the very heart of the State of New York, have not yet died away, and self-gratulations and mutual encouragements are yet the order of the day. In the city of New York, the opening of a portion of the New York and Erie railroad has opened the sleepy eyes of our citizens to the advantages they have quietly suffered to lie unemployed or to pass into the hands of their neighbors. Stimulated by the enterprize of Boston, our citizens have determined that the New York and Erie and the New York and Albany railroads *shall* be completed. In Philadelphia, the opening of the Philadelphia and Pottsville railroad has justly been celebrated as the completion of the most important work in that State of public works. Philadelphia is now made, without doubt, the great coal mart of the Union, being but a few hours travel from the greatest deposit of anthracite in the world.

In addition to all this, the recommendations of the Heads of the War and Post Office Departments, that railroads being essential to

the necessities of the Government, should be, by mutual contract, secured perpetually as transporters of the public mail and the United States troops,—have turned the attention of the whole community to this subject, and with the very few exceptions, that always must be expected, the voice of the whole nation has been heard in favor of railroads. They are demanded for the public convenience,—for the public comfort,—for the public safety.

Such being the case, it is highly necessary and proper that the discussion of the subject should not be entirely left to the popular view of the question, but receive the support and countenance of the Profession. What we most want at the present time is strictly accurate and numerical details of the cost of construction and management of roads *at present prices.* It is well known that the price of railroad iron at present is not much more than half of that paid for most of the rails now in use, and other materials as well as labor have also been lowered in price in various degrees. Correct information upon these points is therefore highly interesting, and all details will be eagerly sought for.

Engineers are, for many reasons, the persons best qualified for giving such information; and it is not a little surprising that they have, with few exceptions, so uniformly abstained from appearing in any manner before the public or even before the profession as contributors to the general fund of information. We have so often spoken of this before, that we shall not dwell any longer upon the subject, except to remind our professional readers that what we recommend is a matter of the highest importance to their interests, and not to be neglected without detriment both to the public and themselves.

[For the American Railroad Journal and Mechanics' Magazine.]

FAILURE OF RAILWAYS.

I had, at first, only cursorily glanced through Mr. Ellet's pamphlet on this subject, and was happy to think it a panacea for all the ills of railways, but on reading the notice of it in the number of your Journal of the 1st January, I have been led to give the subject a further consideration, and agreeing mainly with that notice, I am now disposed to regard Mr. Ellet as laboring under a delusion.

Besides presenting some *self evident* matter, which sad experience in most instances has rendered only the more *palpable*, the ground taken by Mr. Ellet is, as I understand him, as follows:

That costly roads have been built where cheap ones were only want-

ed; and that the present actual amount of trade and travel in all cases, ought to have been, and must in future, be the exact measure of the solidity, and consequent outlay for both road and machinery.

In all discussions it is of all things important to start with a right understanding of terms. What is then, *at this day*, understood by a railway? I should say, there can be made only two degrees of them, the positive without, and the superlative with steam power; the latter applied to it by means of the locomotive, to which it owes all its value, and which as having most developed the two greatest elements of economy, velocity and power—is distinguished as the most remarkable invention of the age. In the progress of this machine, it was found that the heavier it could be used, its weight at the same time being more equally diffused over the rail, the more it could do and the longer it could work, with less expense for repair to itself or the road. The true economy of the railway depending thus on the *the weight of the locomotive*,* it consequently becomes the rule, as well for its own cost, as of an *adequate* structure of road to sustain it, and to crown the whole system with the indispensable element of safety.

The object of this improvement in particular, being to give at first much cheaper and better accommodation to the existing business, and afterwards to multiply and extend it—a higher standard than the old or ordinary facilities would be necessary to effect that object. Throwing the turnpike† out of view, the steamboat and the rail-

* Messrs. Eastwick and Harrison, of Philadelphia, were among the first to make these massive eight wheel engines really effective. Baldwin and Co. have recently put out one on six wheels of thirteen tons, nearly the whole adhesion being obtained from that weight, and in a recent chance occasion she drew three hundred and thirty tons over a grade of thirty-two feet, adapting herself with every facility to a curve of ninety degrees. The desideratum of having no friction without a corresponding compensation, will thus be secured, while heretofore one-third of the weight of the engine has been worse than lost, in doing injury without any return.

† To give the reader an idea of the cost of an ordinary turnpike and Macadamized road as compared with that of the railway, and he has now learnt that the two are scarcely comparable as to relative utility, we append the cost of portions of the Great National Cumberland Road as per report from its engineers. It is graded 30 feet, covered with lime stone the width of 20 feet, and to the depth of 9 inches. The cost of keeping it in repair is not much under that of a good railway:

Portion in Ohio,	average per mile,	- - - - - - -	$11,258
Do.	Indiana do.	- - - - - - - -	$21,102
Do.	Illinois do.	- - - - - - - -	$23,868

The whole length of the road, when completed, will be 595 miles, and the total cost between $8,000,000 and $9,000,000. The lowest cost per mile in the above averages are given at $4,400 and $6,800 per mile. This latter is about the average at present for grading a railway; and estimates for an entire road with heavy edge rail and motive power and cars, do not *now* exceed $20,000 to $25,000 per mile. In viewing the railway as an *arm of defence* alone, what a waste does the Macadamized road appear at even half the cost of the former. In this view, look at the Pottsville and Philadelphia railway, which, at its opening, threw into Philadelphia by one engine and train 2,150 miners, accompanied by another engine and train of coal, which could as well have been a park of one hundred pieces of artillery, in 6 hours, from a distance of 100 miles.

way, as we now find them, have created that standard in the public mind, and by which it would not now be satisfied with a lesser speed than twenty miles per hour with safety, and would only regard that an improvement, which possessed the power to surpass that rate, as the modern railway is in fact able to do.

The idea, however, is certainly novel, that any facility designed *to promote* the intercourse of trade and travel, should, according to Mr. Ellet, be *tied down* to a specific capacity, and limited only to the existing business, which could never be exactly ascertained,—and which naturally elastic and expansive, would require that that facility should be so too, at least in an equal, if not in a greater degree. The railway it is, that is made of this peculiar stuff; and if not, in some cases, immediately remunerating to its projectors, it has in all been sure to give amplitude and scope to the community so lucky as to possess it, and particularly if of the more modern construction.

The railway system is now undoubtedly successful as a whole; and were the secret history of such as are exceptions, to be had, it would most likely unfold other than the mere apparent causes of their early and present want of success. A report from the Winchester and Potomac railway furnishes some facts and views, which, as apropos to our subject, may be here detailed,—its career is the type of many others.

This road has been in operation for some years, running from Harper's Ferry, thirty-two miles, to Winchester, Virginia, has thirty feet grades, is a slight flat bar structure, and in the last year transported about 20,000 tons, principally flour.

It started with locomotives, then determined by its engineers as most suitable to such a road, weighing only four and a half tons, capable of drawing only nineteen to twenty tons over the above grade of thirty feet, yet with this light engine was it continually disordered, and its income almost entirely consumed annually in adjustment and repairs. The want of continuity in the road was a cause of great expense to it, in the necessity for transferring all the freight at the Ferry, by which treble and quadruple the time was taken to convey freight, etc,, to and from Baltimore and Winchester, *and this time was so much capital actually lost;* the business of the two roads was also limited by the amount of freight that could be manifested and transferred at the Ferry, and was consequently fatal to any increase of revenue.

An entire revolution has now been effected in the arrangement of this road: the Ferry has been bridged, and the road made con-

tinuous,—the superstructure readjusted,—and in place of the four and a half ton engines, drawing only nineteen to twenty tons, they have now put on one of thirteen tons on eight wheels, capable of drawing one hundred tons and upwards, having recently delivered, in one load, at the Ferry, eleven hundred and seventy-five barrels of flour, and that over a flat bar, on which her power is at least twenty-five per cent. less than on an edge rail, thus performing the work of three or four of the lighter engines, *with even less injury to this fragile road than the lightest of them.* This was an amazing change in the economy of their affairs, and will be the more visible in the following statement:

	Cost.	Expense of running per day.	Nett freight.
One 13 ton engine,	$8,500	$25	Load, 120 tons.
Four 4½ "	12,000	95	" 80 "
Total saving,	$3,500	$70	40

If then to this saving in capital, daily outlay and gain in power, be added the lesser risk of disarrangement to the business of the road, and a smaller establishment being necessary for repairs of road and machinery,—the substitution of the ONE larger engine, would economise at least one hundred dollars per day, and which would be *the more important at the start with a small business,* than afterwards with a larger one. Upon this, the report remarks, (Railroad Journal, of 1st September.)

"This is but one of the results of experience in showing the necessity for increasing the power without increasing the expenditure, and diminishing the gravity or pressure of the engine, by multiplying its points of contact with the road."

"The question is now no longer how or what we shall carry, but in what manner we shall command the greatest amount of trade,—how we shall lengthen the radius and extend the circle of commerce."

In this last quotation, is indeed expressed the scope and purpose of the locomotive railway; and immediately above it, is it practically demonstrated that, as its *weight and cost* are increased, so is its economy;—and the most recent recognition of this principle is found in the adoption on the Massachusetts Western railway of Mr. Winan's nineteen ton engine,* distributed on eight driving

* "We learn with great pleasure that the twenty ton engine from Baltimore, with its whole weight on eight drivers, works admirably between Greenbush and Springfield, even on the Hudson and Berkshire (flat bar) railroad. This engine can carry a very heavy load, say one hundred tons freight over the eighty feet grade of the Western railroad."—*Boston Transcript.*

wheels. Were there no other developments of the system, this is enough of itself to overthrow Mr. Ellet's theory; one extreme of which, may be described as contemplating *a mere wooden road, to cost only one thousand dollars per mile, an engine of a half of a ton weight, a car and engine shed to cost only fifty dollars, and the whole concern to be managed by* ONE PERSON, *to unite therein the various capacities of engineer, conductor, fireman, and treasurer; and if the road be* VERY SMALL, *superintendent and general commissary;* and this thing he claims, must not be thought *too contemptible* to be called a railway. His other extreme, which contemplates a road to cost as high as thirty thousand dollars per mile, and a locomotive of twenty-five ton weight, about accords with the present progress made in this improvement; and when roads must hereafter be built, for few will now be attempted, except under a strong necessity, he will find, as we believe, that they will be required in all cases, to be built nearer this extreme, without much reference to the actual existing business to be accommodated. (See pamphlet, page 11.)

And as going to show that a substantial road at the start, and under all circumstances, is demanded by the economical principle of the weight of the locomotive, we quote from a late memorial to the Maryland Legislature, from the Elkridge and Annapolis railway, which, although far in advance of any business to support it, yet has thought it wisest to provide itself at first with the best means of creating it:

"Your memorialists would refer your honorable body to its memorial to the General Assembly, at the last session thereof, for a more detailed explanation of the causes of this excess of expenditure, and especially of the reasons which influenced your memorialists to adopt a heavy edge rail, forming a permanent road, in the stead of the one *which had been found by experience to be wholly inefficient.*"

As a general rule a good article *at first* is cheapest in *the end*, and least of all is the railway an exception to this rule; it had better, therefore, be never attempted, except when it can be afforded *good and costly*, as then only is it enabled to evolve all its great effects; and that it does not admit of the graduated scale to which Mr. Ellet would subject it, is further evident *in the necessity* for the same *speed and safety*, whether you have one or a thousand passengers to transport.

Discussion promotes inquiry,—and as this is a subject on which the public mind is still much entangled, every attempt at unravelling it, however feeble, should be thankfully received.

X.

PHILADELPHIA AND POTTSVILLE RAILWAY.

On the 10th of January, a formal opening of the road between Pottsville and Philadelphia took place, which was made the occasion for a joyful celebration, by a dinner at Philadelphia and a ball at Pottsville. It gave some earnest of its immense powers and future utility, by delivering at Philadelphia 2,150 passengers in 76 cars, forming a train 1,255 feet long, drawn by one engine, the "Hitchens and Harrison," accompanied by another train of 180 tons of coal, also drawn by one engine. The weather was unpropitious, snow having fallen during the early part of the morning to the depth of several inches.

In the evening of the 10th, after a pleasurable day, a large company sat down to a supper at the Washington House, Philadelphia. On which occasion, after some introductory remarks, Mr. George W. Farquhar, of Schuylkill county, made the following remarks:

The turnpike and the canal, it is true, have already given to our products an access to the great emporium of Pennsylvania, but the magnificent work, the consumation of which we now celebrate, places us in a more intimate relation, and for the advantages of pleasure, information and business, has made us almost a suburb of our parent city. If any thing could strengthen the ties of kindred interest, and of filial affection which bind us to Philadelphia, it is this noble achievement which has been so successfully accomplished. The patriotism and foresight manifested in the conception of this great improvement, the skill which directed it, and the sagacious liberality by which it has been fostered, command alike our admiration and regard. When we reflect upon the multiplied difficulties that have been encountered; when we consider the great natural obstacles that have been surmounted, that the stream has been arched, the valley filled up, and the rocky base of the mountain swept aside—we are compelled to concede enterprize, energy and ability of the highest order to those who have accomplished this most invaluable improvement. But they have done more. They have moved steadily forward, dispelling prejudices, and triumphing over conflicting interests, at a period when public enterprize and individual efforts were sinking under the crushing embarrassments of the times. During this most appalling crisis, when confidence was lost at home, and credit blasted abroad; when common bankruptcy seemed likely to involve not only the citizens, but the States themselves; when your General Government was a petitioner in Europe for a loan of a few millions, and had its petition rejected; when so prostrated were our resources, that dispair suggested the dis-

honest expedient, that though it might be difficult to pay, it was easy to repudiate. Still with a generous confidence in their own resources, through evil report and good report, they have pressed on, conscious that they were bestowing an inestimable benefit upon the community, and that the reward would be commensurate with the struggle. They have victoriously accomplished this glorious adventure—productive of immediate, and pregnant with future advantages. This great work is finished. It stands a monument of the wisdom that conceived, the genius that planned, the energy that sustained, and the mechanical skill that executed it—the model railroad of the day. We gratefully acknowledge the incalculable advantages that the Coal Region will derive from this new avenue to market, and while we admit our own peculiar obligations, we assign, and we believe posterity will assign to the Philadelphia and Reading railroad company a high place among the benefactors of the State. We extend to them the right hand of fellowship, hoping that the connection which they have this day established, may be as beneficial to them as it is advantageous to us.

If it be true that the internal communications of a country are a fair test of its resources and of its progress in cultivation, does not our own State occupy a most enviable position? On the eastern side of the Alleghany, our waters are every where tributary to canals and our railroads pervade the country in all directions. In these improvements we are in advance of the age; but our self-congratulation may be checked by the reflection, that in making them we have incurred an enormous debt. True it is we have been lavish, prodigal, perhaps corrupt, in our expenditures, but are we bankrupt? Let our iron, producing some $22,000,000, and our coal between 4 and 5,000,000; and our agriculture at least double the amount of both the mineral staples, answer the question—as well might a debtor display a well filled purse and refuse on the plea of inability to pay a trifling demand, as for Pennsylvania to point to her mountains of coal and iron, her work shops, and her harvest fields, her canals and her railroads, and talk of insolvency.—Besides we are not to consider our State debt as money lost. It has already greatly benefitted and will continue to benefit the country. Revert to the towns on the Susquehanna some ten years since, and view them now? Their improvement is so great as almost to raise a doubt as to their identity.

Observe the increase in the value of land. Turn to your census, and regard your population growing at a ratio greater than that of any of the old States, not excepting New York, which has also an

extended system of improvement. Our debt has been enlarged, it is true, enormously, but our prosperity has advanced still more rapidly, —and the prosperity has been mainly caused by our railroads and canals. Is it, however, a mere question of dollars and cents? Is the benefit to be estimated only by the money expended and the money to be received?

Independent of their business value, those improvements are a strong bond of union among our citizens,—facilitating intercourse,— they bring us together,—ideas are enterchanged and an increased degree of intelligence and refinement is diffused. If the question were submitted, to retain Pennsylvania as she now is, with all her debt, and with all the advantages accruing from it; and to retrograde to what she was, and what she would now be without her improvements, can any patriot hesitate as to the answer? No one, who has examined the statistics of our State can doubt that her resources, properly husbanded, are sufficient to meet her engagements. If they cannot be liquidated by the ordinary resource, let us resort to direct taxation fairly and honestly proportioned.

Schuylkill county, though sustained by improvements to which the State debt has contributed nothing, will cheerfully bear her quota. We cling fast to the honor of Pennsylvania—we will pledge our mines, our canals and our railroads to preserve it—we will submit to any burden, but the infamy of repudiation.

We must view this railroad as the first link in a connected chain of improvements. When the communication is extended to the Susquehanna, it will intercept a large trade which now descends to the Chesapeake. In conjunction with the contemplated improvements to Lake Erie, it will command a fair proportion of the immense inland business which is now enriching New York. I feel gratified that the railroad cannot be tapped, and that the anthracite coal and iron of this region will find at least a primary market in Philadelphia. It is then emphatically a Pennsylvania work, promoting Pennsylvania interest, and transporting her mineral treasures to her own metropolis. We must bear in mind also that the commodities to be transported are of unquestionable value and of indispensable use—not articles of luxury or even of mere convenience, but those which a judicious policy requires to be supplied as abundantly and as cheaply as possible. Let it be remembered that the great ascendancy of Britain is owing to her coal and iron, and that deprived of them, her manufactures would cease, her trade would perish, and she herself sink into a subordinate grade among the nations. This new avenue will in-

crease the supply and of course diminish the price of that metal, of such universal application that society would be helpless without it. That metal which either as a tool fabricator, or as a component part, is fabricated to minister to all our wants, without which the soldier would be harmless, the farmer useless, and the steam power itself, but an ingenious contrivance incapable of extended practical benefit. The completion of this road will hasten the day when Schuylkill county shall pour her anthracite iron from her numerous furnaces to increase our domestic comforts, and protect us from foreign aggression. This alone would connect this work with our dearest interests. But the more immediate business of the road will be the transportation of coal. It is not our purpose here to enter into the vexed question as to the relative advantages of canal and railroad. We hope and believe that our business will increase with the facilities afforded, and that with the aid of a judicious tariff we should give sufficient occupation for both. It is sufficient here to say that the weight of authority supports the position, that a railroad transacting a general transportation can at least successfully compete with a canal. The mass of our citizens may be indifferent whether the more profitable business be effected by the one or the other route, but the benevolent mind must be interested in the fact, that the existence of this road ensures an abundant supply of fuel at all periods, and as a consequence, at a fixed and reasonable rate. There can be neither a scarcity, nor much fluctuation in price. During the inclement season, when our ice-bound waters exclude the transportation of coal or wood on boats, the railroad will continue its regular supply. The poor man's hearth and the widow's stove will be replenished at an easy rate, and the almost proverbial phrase, "a hard winter for the poor," will lose a part at least of its painful significance.

The certainty of the supply at a price subject to little variation will greatly enlarge the consumption of coal. There are a multitude of furnaces in which wood is now exclusively used; because those interested in them are unwilling to make expensive alterations to adapt them to coal, and then be exposed to the inconvenience of a limited supply, and a varying or speculative price. When it is once ascertained that the quantity will at all times equal the demand, our anthracite in the work-shop, and in the steam boat, will supersede all other fuel. I am then justified in asserting that the necessary tendency of this most interesting improvement is to diminish the suffering of the poor and largely to diffuse and increase the consumption of our mineral staples.

Mr. Chairman: I have trespassed too long upon your attention; I have been led away from my point; and return to it with a toast.

The Philadelphia and Pottsville railroad company:—They have won their way into the heart of the coal region, and in its heart shall they be cherished.—*Abridged from the Miners' Journal.*

CHEAP FUEL.

In contemplating the effects of the recent connection, by railway, of the Pottsville coal mines with tide-water at Philadelphia, the great element of social comfort and economy, cheap and abundant fuel, presents itself in pleasing relief to our view.

From the main body of the coal fields, the principal canal down the Schuylkill, has been able to dictate the toll—and the freighters, an independent interest, have always preyed on all other interests concerned, by taking advantage of every contingency to make what terms they pleased; it was no uncommon thing, therefore, for the freight on that canal to begin in March at 85 to 90 cents per ton, and with the progress of the season to rise to $2 50 per ton: a certain calculation as to cost, was accordingly out of the question.

Under the coming influence and control of the railway, how completely will simplicity, economy, dispatch and certainty, be secured to the trade. Let us compare only the main items: in all minor ones the railway has much the advantage.

As heretofore conducted on the Schuylkill canal, the toll paid in cash at the start, has been 90 cents per ton, and an average freight on delivery, of $1 25, but in future the toll may be put at - - - -	50	
The freight do. - - - -	90	
		$1 40
Cost of the coal at the mouth of the mine paid in cash		1
Active cash capital required for a ton of coal, dealing by canal, which can only be turned once in two weeks on the average - - - - -		$2 40
Hereafter, by the railway, the toll and freight will be paid in *one item*, where the car belongs to the dealer, at - - - - - - - -		$1 30
Cost of the coal at the mine in cash - - -		1
		$2 30

In the case of the railway, however, but ONE DOLLAR ACTIVE CAPITAL is required to pay for the coal at the mine, as a credit for the freight of at least a fortnight can be had by the railway, during which time the dealer can realize the whole cost of the coal including his profit four or five times, to once by the canal; and in this accommodation, the railway is perfectly safe, in having control of the dealer's car, and most generally possession of a portion of his coal on deposit. There is no hold or facility of this sort by the canal.

In looking at this one feature alone, can any one doubt that the railway must get all the trade it will accommodate; and with the attraction of interest thus powerful, it cannot be long before the public, not of Philadelphia alone, but that of the whole eastern seaboard, will be unanimous in carrying this improvement, which has involved so many sacrifices, to its utmost limit of utility. Every development can only give a keener edge to this impulse of interest.

The canals are evidently expecting such a result, and are preparing for a sharp contest, determined to maintain the superiority they have so long claimed as the cheapest carriers, especially in this article of coal.

The following are about the relative costs, delivered afloat in New York, by each of the avenues, which are to enter the list in the grand tournament to come off in the ensuing season, or after the middle of March, 1842, for the amusement and benefit of coal consumers:

Schuylkill railway:

Cost at mine - - -		$1	
Toll on lateral road - -	25		
Toll on main road to Delaware	1 50		
		1 75	
Freight in 200 ton barges through the Delaware and Raritan canal		85	
			$3 60 per ton.

Schuylkill canal:

Cost at Schuylkill Haven - -		1 50	
Freight through to New York, including towage and toll to Delaware and Raritan canal - - - -		2 35	
Toll to Schuylkill canal - -		45	
			$4 30 "

Shipped by sea from Philadelphia, about the same.

Lehigh canal:

Cost at mouth of Morris canal at Easton		2 50	
Freight per Morris canal, supposing it enlarged for 50 ton boats - -		1	
Toll at half a cent per ton per mile -		50	
		——	$4 00 per ton.

Shipped by way of Bristol, about 25 cents higher per ton.

Lackawanna canal:

Coal delivered at Honesdale - -		1 40	
Freight to Rondout - - -		1 37	
Toll - - - - - -		40	
		3 17	
Freight, etc., to New York - -		53	
		——	$3 70 "

In giving the above as the relative pretensions to strength of the parties, they must be understood as being bared to the skin, and no profit allowed in either case, except to the railway as a carrier. The latter entering as a new and modest knight, rather to give variety to the contest and to fill up the lists, will expect from the public, to whom the prize will belong, a liberal assistance in its preparation for a fight, *thought by many to be altogether so unequal.*

[From the Civil Engineer and Architect's Journal.]

ON THE MOMENTUM PROPOSED BY MR. JOSIAH PARKES, AS A MEASURE OF THE MECHANICAL EFFECT OF LOCOMOTIVE ENGINES. *By the* COUNT DE PAMBOUR.

In the *Transactions of the Institution of Civil Engineers*, Vol. III, Mr. J. Parkes has published a paper *on steam boilers and steam engines*, in which the object is to propose, as a new measure of the mechanical effect of locomotive engines, what he calls the *momentum* produced by the engine, that is to say, the product of the mass, in tons, of the engine, tender and train, multiplied into its velocity, in feet per second. According to him, this momentum being measured at one velocity, for a given engine, the effect of the same engine, at any other velocity, will be immediately deduced from it by a single proportion (page 130,) without troubling one's head about the inclination of the road, the friction of the wagons or the engine, the counter-pressure due to the blast-pipe, the resistance of the air, or, in fact, any of the resistances really encountered by the engines.

To establish this new idea, Mr. Parkes's first step is to represent as altogether faulty and impossible every calculation or experiment made by others, to take account of the divers resistances offered to the motion of the engines. With this view he enters into a long and malevolent discussion on the experiments of our *Treatise on*

Locomotive Engines, and on all the experiments on the same subject published by different engineers; and to demonstrate the difficulties insurmountable, in his opinion (page 124, 129,) and the uncertainty attending such researches, he indicates several verifications which, as he says, these experiments ought to satisfy, and which they do not satisfy. As Mr. Parkes gives on the subject a great number of arithmetical calculations, the errors of which are protected against detection by the heap of figures presented, we shall first enter, with some detail, into the examination of his pretended verifications, and afterwards shall discuss the value of the new measure proposed by him to represent the mechanical effect of locomotive engines.

On seeing the *fundamental* errors on which his reasoning and his calculations are grounded, the inaccuracy of his criticisms and of the results at which he has arrived, will be at once recognised.

1st. Mr Parkes proposes to calculate the pressure at which the steam was necessarily expended on the cylinder of each engine submitted to experiment, in order afterwards to compare that pressure with the pressure resulting from the sum of the different determinations of resistances exerted against the piston, according to the *Treatise on Locomotive Engines*. With this view, he seeks, from the velocity of the engine, the number of cylinders full of steam which were expended per minute. Comparing the volume thus obtained to the volume of water vaporized in the boiler, he concludes the *relative* volume of the steam during its passage into the cylinder; and finally, recurring to the table of the relative volumes of steam under divers pressures, contained in our *Theory of the Steam Engine*, he concludes the pressure which the steam must necessarily have had (page 82, etc.) This is conformable to our theory developed in the *Treatise on Locomotive Engines*, which, in fact, Mr. Parkes entirely adopts. But to perform this calculation, Mr. Parkes takes the *average* velocity of the whole trip from Liverpool to Manchester (page 85, and table viii., col. 10; table xiii., col. 9; table xvi., col. 2, etc.,) and from that velocity he pretends to deduce the *mean pressure* of the steam in the cylinder during the same trip. Now it will be easy to prove by an example that this mode is altogether faulty.

Suppose, in effect, the engine Atlas has travelled a distance of 30 miles in an hour and a half, vaporizing 60 cubic feet of water per hour. As the wheel of the engine is 5 feet in diameter, or 15·71 in circumference, as there are two double cylinders full of steam expended at every turn of the wheel, and as the capacity of those two double cylinders, including the filling up of the steam ways, amounts to 4·398 cubic feet, it follows that the volume of the steam which passes into the cylinders per mile performed, or per distance of 5280 feet, is $\frac{5280}{15{\cdot}71} \times 4{\cdot}398 = 1478$ cubic feet.

This premised, when Mr. Parkes refers to the average velocity of the whole trip, to value the pressure in the cylinder, as that velocity is 20 miles per hour, and as the vaporization at the same time is 60 cubic feet of water per hour, he finds, for the ratio of the volume of the steam expended to the volume of water, $\frac{1478 \times 20}{60} = 492{\cdot}7$. Con-

sequently, recurring to the table of the relative volumes of steam under different pressures, he obtains for the corresponding total or absolute pressure 56·66 lb. per square inch; and deducting the atmospheric pressure, he obtains for the effective pressure, 41·95 lb. per square inch.

But to show that this mode of calculating, from the average velocity, can only lead to error, let us suppose that, by reason of the divers inclinations of the portions of the railway, the first 15 miles have been traversed in half an hour, and the other 15 miles in an hour, which still makes 30 miles in an hour and a half; as 30 cubic feet of water will have been vaporized in the first half hour, or during the passage of the first 15 miles, and 60 cubic feet of water during the next hour, or in the passage of the last 15 miles, it is plain that the volume of the steam will have been respectively in each of those times $\frac{1478 \times 15}{30} = 739$ first, and afterwards $\frac{1478 \times 15}{60} =$ 369·5. Whence results, according to the table, that the effective pressure of the steam will have been successively 21·62 and 62·95 lb. per square inch.

Thus, during the first half hour the effective pressure will have been 21·62 lb.; during the second half hour it will have been 62·95 lb., and during the third again 62·95 lb. Consequently, taking account of the time during which the pressure has had these respective values, it is plain that the mean effective pressure in the cylinder will really have been $\frac{21{\cdot}62 + 62{\cdot}95 + 62{\cdot}95}{3} = 49.17$ lb. per square inch, and not 41·95 lb. per square inch, as given in Mr. Parkes's calculation; which, by the fact, supposes all the portions of the trip to have been performed in equal times. In this case, therefore, which has nothing in it but what is very ordinary, there would be an error of 7·22 lb. per square inch out of 41·95; that is an error of more than $\frac{1}{6}$ on the effective pressure of the steam. It is evident that the calculations, such as Mr. Parkes makes it, is exact only for portions of road composed of one inclination, or travelled with *uniform* velocity, and that it cannot apply to the total passage of a line composed of different inclinations. For further elucidation on this head, we refer to chapter XVII., relative to inclined planes, of our *Treatise on Locomotive Engines*, second edition, and to chapter XII. of the same work, in which all the experiments considered by Mr. Parkes are calculated.

2nd. We have just shown the first error which Mr. Parkes introduces, as a fundamental basis, in his calculation of the pressure of the steam in the cylinder. But he does not stop there. In the table of experiments on the vaporization of the engines (*Treatise on Locomotive Engines*, page 175 of first edition, and page 253 of second edition,) we have given the average velocity of the engines during each trip; and that velocity is obtained simply by dividing the whole distance performed, by the time employed in performing it, as is seen in the table in question. It would be natural then for Mr. Parkes, who, as has been said, is satisfied with average velocities

in his calculations, to take those which are given in the table; but instead of that, he augments almost all the velocities about $\frac{1}{4}$. Thus, for instance, the Vulcan, which travelled 29·5 miles in 1 hour 17 minutes, and whose average velocity in consequence was stated to be 22·99 miles per hour, had, according to Mr. Parkes, a velocity of 26·90 miles per hour. The velocity of the Vesta rises from 27·23 to 31·60 miles per hour, and so of the others (table viii., col. 10; table xiii., col. 9; table xvi., col. 2.) The critic falls into this new error because, in the *Treatise on Locomotive Engines* (page 324 first edition, and page 311 second edition,) in speaking of fuel, it is said that, when the engines ascend without help the inclined planes of the Liverpool and Manchester railway, the surplus of work, thence resulting for them, equals, on an average, the conveying of their load to $\frac{1}{4}$ more distance, and Mr. Parkes logically concludes from this that the *velocity* of the engine must be by so much increased (pages 86, 112.) So that if an engine perform 1 mile in 4 minutes, ascending a plane inclined $\frac{1}{80}$, which renders nearly five-fold the work of the engine, it would follow, from this calculation, that the velocity would not have been 15 miles per hour, but $15 \times 5 = 75$ miles per hour, since the quantity of work done would have been five-fold! Mr. Parkes's error proceeds from his having applied to the velocity a correction which refers only to the *work* done, and, as a consequence, to the corresponding consumption of *fuel*.

But on examining what effect results from this substitution of the imagined velocity of Mr. Parkes for the observed velocity, it will be remarked that whenever an engine is obliged to ascend without help one of the inclined plains of the Liverpool and Manchester railway, it exerts at that moment, as we have said, an effort five times as great as upon a level, and draws its load less rapidly. One would deem it then allowable to conclude, that the average pressure of the steam in the cylinder must be augmented, since during a certain portion of the trip, the effort required is greater, and that the *useful* effect per unit of time must be diminished, since during the same time the useful load is drawn at less velocity. But no. Mr. Parkes's calculation, by augmenting then, the apparent velocity of the engine, demonstrates that, in this case, the average pressure in the cylinder becomes on the contrary much *less*, and that the useful effect becomes much *greater*. So that the error committed produces itself here in the two opposite ways.

With these elements, Mr. Parkes establishes the *whole* of his calculations and tables, to the very end of his paper (table viii., col. 10; table ix., col. 19; table xiii., col. 9; table xiv., col. 2; table xvi., col. 2;) and as, to augment the evil, this pretended correction is made only on one portion of the experiments, namely those in which the engines were helped up the inclined planes, without being made in the other cases there results an inexplicable confusion in all the calculations. Thus, it happens that Mr. Parkes's determination of the volume and pressure of the steam consumed by the engines (table ix., col. 26, 29,) the horse power produced per cubic foot of water vaporized, or the quantity of water employed to produce one horse power (table x., col. 44, 45, 49, etc.,) the momentum generated

per pound (table xiii., col. 11, 12; table xiv., col. 9, 10, 11,) and all the consequences thence derived are in every way erroneous.

To show by a particular example, the fallacy of the results to which Mr. Parkes has been led by this wholesale and faulty way of calculating, we need only refer to the two experiments of the Fury, which he extracts from our work on locomotive engines. He pronounces, "with certainty," (page 128,) these two experiment to be erroneous, as exhibiting an engine performing more work at 23 than at 21¾ miles per hour, in the ratio of 24 to 19. Now, to arrive at this conclusion, Mr. Parkes first takes the velocity of the engine, not at 18·63 and 19·67 miles per hour, as given from actual observation, page 175 of the first edition, and pages 253 and 392 of the second edition of our Treatise on Locomotive Engines, but at 21·79 and 23 miles per hour (table xiii., col. 3.) Secondly, in comparing the work done in the two trips, he does not take into account that the first of the two trips has been made from Manchester to Liverpool, and the second on the contrary from Liverpool to Manchester. But there is a general rise of the ground from Manchester towards Liverpool, and from that circumstance, the gravity opposes more resistance in that direction than in the contrary one. Thus it happens that a less train carried on the line from Manchester to Liverpool, may require from the engine, a greater quantity of labor than a heavier train carried in the opposite way. In effect, by referring to pages 501 and 504 of the second edition of our work on locomotives, it will be found that in the two experiments under consideration, the work done by the Fury, in carrying the two loads of 43·8 and 51·16 tons, besides tender, from Manchester and from Liverpool respectively, to the other end of the line, was

43·8 tons, from Manchester to Liverpool, equal, gravity included, to -	1964 tons to 1 mile.
51·16 tons, from Liverpool to Manchester, equal, gravity included, to -	1837 tons to 1 mile.

We see, therefore, that when we take an account, as we ought to do, and as Mr. Parkes has not done, of the surplus of labor caused by gravity, the work required of the engine is in reality more in the first case than in the second, although the load itself is less. Consequently the engine ought to have accomplished the second trip in less time or with a greater average velocity than the first, which in fact it did, and which had led Mr. Parkes to pronounce with such "certainty" the experiments to be eroneous.

This example shows that the calculation of Mr. Parkes, made with an erroneously averaged and exaggerated velocity, in which, moreover, he omits the gravity on the inclined planes, the resistance of the air, the friction of the engine, and all the other resistances really opposed to the motion, leads him to a *very inaccurate* measure of the work performed by those engines; and this refers to the whole of the results obtained, table ix., col 29—32; table x., col. 41—50; table xiii., col. 11, 12; table xiv., col. 9, 10, 11; table xvi., etc., and also to his comparison of locomotive and stationary steam engines, which we shall notice further on.

3d. After having calculated *very exactly*, as we have shown, the pressure of the steam in the cylinder, Mr. Parkes compares the result which he has obtained, with the total pressure on the piston resulting from the partial resistance suffered by the engine, according to the *Treatise on Locomotive Engines;* and as, in the first edition of that work, the author had confined himself to mentioning the pressure against the piston due to the action of the blast-pipe, without making any experimental research on the subject, Mr. Parkes, without noticing the results presented since in the *theroy of the steam engine*, (page 161,) takes the difference between the two results as necessarily expressing the pressure due to the blast-pipe (pages 82, 83;) and he demonstrates the inaccuracy of it. Here we perfectly agree with him; for besides the errors already pointed out in his researches of the pressure of the steam in the cylinder, every thing variable than can occur in the different data of resistance, now passes to the account of the pressure due to the blast-pipe, and must necessarily come to falsify the calculation of it. Thus, for instance, in the experiments, a great deal of water was lost by *priming*, and there resulted an apparent vaporization greater than the true one. A part of the difference between the calculated and the observed pressure was therefore to be attributed to that cause, though it could not be accurately measured; but, by the calculation of Mr. Parkes, it all passes to the account of the pressure due to the blast-pipe. Similarly, the resistance of the air, then imperfectly computed in the total resistance for an average velocity of about 12 miles per hour, is found, in all cases of greater velocity, to augment considerably the pressure due to the blast-pipe, and on the contrary to diminish it in all cases of less velocity. A favorable or an unfavorable wind necessarily produces similar effects. Thus, circumstances, combined with the fundamental errors already introduced in the calculation, raise or lower that pressure to all imaginable degrees (pages 87, 88, 90, 91;) and it will be readily imagined that such a determination cannot be exact.

4th. Mr Parkes has observed, in the experiments of the *Treatise on Locomotive Engines*, and particularly in two of them, made with the Leeds engine, and quoted in the *Theory of the Steam Engine*, that the useful effects produced by the same quantity of water vaporized varies, according to different circumstances, and he is amazed at it; for, as he affirms, the useful effects produced by the same quantity of water vaporized, in the same time and under the same pressure in the boiler, ought in all cases to be identical (pages 104, 119.) But this again is merely an error of the critic; for if we suppose a locomotive engine drawing a heavy load at a small velocity, since it is only at a small velocity that the engine has to overcome its friction, as well as the atmospheric pressure against the piston, and, above all, the resistance of the air against the train, it follows that out of the quantity of total work executed, there will be but a trifling portion lost in overcoming those resistances; but if, on the contrary, we suppose the same engine performing precisely the same quantity of *total* work, but drawing a light load at a great velocity, it is obvious that a much greater part of the work

done will be absorbed in moving, at that velocity, the resistance which represents the friction of the engine, as well as the atmospheric pressure against the piston, and in overcoming the resistance of the air, which increases as the square of the velocity ; and consequently there will remain a much smaller portion of it applied to the producing of the useful effect. Hence, in the two cases considered, the useful effects produced by the same quantity of water vaporized, so far from being identical, will, on the contrary, be very different from each other. Mr. Parkes may, besides, satisfy himself on this point, by perusing the *Theory of the Steam Engine*, in which he will find numerous examples of steam engines, in which the useful effect of one cubic foot of water varies in very wide limits, according to the velocity of the motion or the load imposed on the engine ; and he will find it explained theoretically in chapter XII., of the *Treatise on Locomotive Engines*, or in chapter III., article 11, of the *Theory of the Steam Engine*. Thus Mr. Parkes's reasoning errs again by the basis itself.

5th. But there is another principle to which Mr. Parkes would subject all the observations of vaporization of locomotive engines. He remarks that in the two experiments above cited, the total resistance opposed to the motion is different in the two cases. Consequently, says he, the quantities of water vaporized by the engine in the same time must be in proportion to the pressures in the cylinder, and the experiments ought to satisfy this condition (pages 99, 100.) Upon this point he is merciless.

To establish this new principle, Mr. Parkes recurs to the *Treatise on Locomotive Engines* itself. He quotes a passage, in which, supposing the same engine travelling the same distance with two different loads, the author says postively that the distance travelled being the same in both cases, the number of turns of the wheel, and consequently the number of strokes of the piston given by the engine, that is to say, the number of cylinders full of steam, or finally the total volume of steam expended, will also be the same in both cases ; whence results that the same volume will successively have been filled with two steams at different pressures, or in other words, at different densities ; and consequently the quantities of water which have served to form those steams will be in proportion to their respective pressures (page 310—312 of the first edition.) Thus, this passage establishes very distinctly that the quantities of water vaporized, *for the same distance*, are in proportion to the pressures of the steam in the cylinders. But what does Mr. Parkes conclude from this ? Why, that the quantities of water vaporized *in the same distance* are in proportion to the pressures in the cylinder. Now it happens to be just the contrary ; for, if we suppose, by way of example, the two pressures to be in the ratio of two to one, the volumes of water vaporized for the same distance traversed, will also be in the ratio of two to one ; but if the time employed in performing the distance in qustion be two hours in the first case, and one hour in the second, it is plainly the quantities of water vaporized in two hours and in one hour respectively, which will be one to the other in the ratio of two to one, so that the vaporizations per

hour, or *in the same time*, will be equal, instead of being in the ratio of the pressures. Thus it is clear again that Mr. Parkes's principle rests but on a new error, which consists in making a confusion between the vaporization for the same distance and the vaporization for the same time.

6th. A final observation of Mr. Parkes (pages 89, 90, 98,) is this, that in some experiments, the locomotive engines produced, for the same quantity of water vaporized, a greater useful effect than several stationary high pressure steam engines, or even than several condensing steam engines; and he considers this result as a proof of the inaccuracy of those observations; for, says he, the locomotive engines having to contend with the pressure arising from the blast-pipe, which the high pressure engines have not, and also with the atmospheric pressure, neither of which resistances the condensing engines have to contend with, it is incontestable that they cannot even produce equal effects, much less superior ones (page 104.) But this reasoning is as unfounded as those we have already noticed; for, since the useful effect of steam engines, for the same vaporization, diminishes as the velocity of the motion increases, which has been already explained above, and which is found developed, either in chapter XII., article 2, of the *Treatise on Locomotive Engines*, second edition, or in chapter III., article 2, section 1, of the *Theory of the Steam Engine*, it is easy to conceive that a locomotive working, for instance, at its maximum useful effect, that is to say, with its maximum load, and consequently at a very small velocity, at which the pressure due to the blast-pipe and the resistance of the air are nearly null, can produce a useful effect greater, nay, much greater than a stationary high pressure engine, working on the contrary with a light load and a great velocity. The same inferiority of effect may also occur in a condensing engine, because an engine of that system working, for instance, at 16 lb. pressure per square inch in the cylinder, and condensing the steam to 4 lb. per square inch *under the piston*, where the pressure is always greater than in the condenser, loses, by that fact alone, a quarter of the power which it applies; whereas a locomotive, working at 5 atmospheres in the cylinder, and at a very small velocity, which renders almost null the pressure due to the blast-pipe, suffers, by the opposition of the atmospheric pressure, a loss equal to only one-fifth of its total power. Hence, definitively, in the latter engine, the counter-pressure against the piston destroys a smaller portion of the total power applied, and consequently, without even noticing the difference of friction of the two engines, or entering into any other consideration relative to the velocity, it is conceivable that the useful effect of the locomotive may be found greater.

But if a more complete calculation be desired, it will be easy to furnish it; for the relative volume of the steam at 16 lb. pressure per square inch, being 1672 times that of water, it is plain that if S represent the number of cubic feet of water vaporized per minute in the boiler, and if a represent the area of the cylinder expressed in square, feet, 1,672 S will be the volume of the steam generated per minute, whence results that $\frac{1672\,S}{a}$ will be the velocity, in feet,

per minute, assumed by the piston of the engine working at that pressure. Moreover, the *effective* pressure of the steam or the load which the piston can support, is 16—4=12 lb. per square inch; which gives $12 \times 144\ a$ for the total resistance, in pounds, supported by the piston. Thus, in the condensing engine, the effect produced by the number S of cubic feet of water, expressed in pounds raised one foot per minute, is $1672 \times 12 \times 144\ S = 2,889,216\ S$. Calculating in the same manner the case of the locomotive engine, we find that the effect it produces for the same vaporization S, working at the total pressure of 75 lb. per square inch, or at the effective pressure of 60 lb. per square inch, and expressed in pounds raised 1 foot per minute, is $381 \times 60 \times 144\ S = 3,291,840\ S$. Therefore, finally, its useful effect, per cubic foot of water vaporized, will exceed that of the condensing engine, and this again is a circumstance, examples of which will be found in the *Theory of the Steam Engine.*

Thus this new peremptory condition which the experiments ought to satisfy, is as unfounded as the former ones; and, in fact, Mr. Parkes contradicts it, himself, a little further on (pages 157, 158,) so that we might have referred his first argument to his second, for refutation. But, besides the foregoing observations, it must be borne in mind that the velocities employed by Mr. Parkes, for locomotive engines, being nearly all considerably augmented, as has been explained above, he must necessarily arrive (pages 85, 87, 89, 92, and tables x., xiii., xiv., xvi.,) at exaggerated results, for the effects which he supposes to have been produced by those engines; and therefore his comparison between locomotive and stationary engines, is altogether founded upon false calculations.

It is remarkable, finally, that in applying the preceding considerations to all the experiments published on locomotive engines, by different engineers, namely, Messrs. R. Stephenson, N. Wood, E. Woods and Dr. Lardner (pages 102, 117, 118, 159,) Mr. Parkes finds that the conditions to which he proposes to subject those experiments are not verified in them. Such a result ought to have put him on his guard against the validity of his own arguments; but the want of knowledge in the principles of machanics and of habit in mathematical reasoning (the author tells us that he is more accustomed to handle the hammer than the pen,) causes him to heap errors on errors, combining and complicating them unawares, till he arrives at a point where he does not produce a single result that is not erroneous.

There is a matter of surprise in the numberless errors contained in the paper of Mr. Parkes, and of which, for the sake of brevity, we have noticed merely the principal ones, reserving the rest for another opportunity if necessary. But on inquiring what was the end he had proposed to himself, what was to be definitive consequence of his labor, one is yet much more surprised.

His object is to propose a new measure of the effect of locomotive engines; and this *new* measure is what he calls the "momentum" generated, that is to say, "the product of the mass, in tons, of the engines, tender and train, multiplied into its velocity, in feet per

second." This standard is to "represent the respective mechanical effect produced per second by each engine," (page 128.)

Now, the true mechanical produce includes the whole of the resistances and frictions really overcome by the engines; that is to say, the friction of the carriages, the friction of the engines, the gravity of the mass on the different inclines traversed, the atmospheric pressure, the pressure due to the blast-pipe, the resistance of the air, etc.; and in multiplying the sum of all these resistances, by the velocity of the motion, we shall have the mechanical effect produced. But, if among all those divers resistances, we take account *only* of the friction of the carriage, and the engine, omitting all the rest, and if we suppose, for an instant, that friction to be 6 lb. per ton, as well for the engine as for any other carriage, we shall have the effect produced, in multiplying the weight of the train, tender and engine included, first by 6 lb., and afterwards by the velocity of the motion. Now, it is evident that in calculating thus, we shall have exactly the same number given by the computation of Mr. Parkes, excepting that all of them shall be multiplied by 6. Therefore, the new measure proposed comes merely to this, that the effect of the engines will be calculated by the friction of the carriages only, and that of the engine considered as a mere wagon, and the results divided by 6.

But, as this pretended "standard" comprehends only a portion of the resistances really overcome; as it does not include the gravity of the train, which may, according to circumstances, offer a resistance exceedingly great, or null, or even act in favor of the motion; as it does not include the counter-pressure due to the blast-pipe, which varies according to the velocity, the rate of vaporization and the size of blast-pipe; as it does not include the total friction of the engine, but only the friction of its wheels, as a single wagon; as, above all, it does not include the resistance of the air, which, from experiments of which Mr. Parkes is "utterly ignorant" (page 124,) varies according to the bulk of the train and the square of the velocity, so that the quantity neglected, on that account, in the calculation may, at times, be quite trifling, and at other times, exceed the *momentum* of Mr. Parkes itself; as in fact this pretended *new* measure is nothing more or less than the common *useful effect* of the engine, as given in many works and particularly in our *Theory of the Steam Engine*, and *Treatise on Locomotiv Engines*, with these differences only, that in Mr. Parkes's calculation, it includes also the weight of the engine, and that it is erroneously computed, inasmuch as, the multiplying the weight of the train, in tons, by the velocity, the calculation is made as if the whole weight were raised up in the air by the engines, instead of being dragged or rolled along the rails; as, finally, this pretended standard, instead of being constant, varies with the velocity, just as well as what Mr. Parkes calls the *commercial* and *useful* effects, so that it is not more easy to know the one than the others, or that the rule of Mr. Parkes, which we are going to quote, refers to the one just as well as to the others; for all those reasons, then, we see that the aforesaid measure is not new, that it does not measure the mechanical effects of the

engines, and finally that it is nothing more or less than the common useful effect (weight of engine included,) calculated in considering the whole train raised up in the air and the engine as a mere wagon.

After having thus found upon *reasoning* the accuracy of his new measure of the mechanical effect of the engines, Mr. Parkes proceeds to show the "powers of this method of analysis" (page 131.) Collecting all the erroneous results which he has obtained in his tables, and admitting then, as accurate, the experiments of the *Treatise on Locomotive Engines*, which he thought of demonstrating false before, Mr. Parkes forms a table in which he sets in view, on one side, the vaporization effected by the engine, and on the other side the useful effect produced, giving it only the name of *momentum*, when it includes the weight of the engine besides that of the wagons. Then comparing the vaporization to the effect produced, and taking an average, not upon his own experiments, *since he has made none*, but upon all the experiments which he has collected from the divers works published on the subject, he presents (page 130,) as the result of his labors, the following conclusion, which he proposes to substitute in place of every other kind of research on locomotive engines.

When the velocity of a locomotive engine is augmented in the proportion of 1·52 to 1, the vaporization necessary to produce the same effects varies in the following proportions:

To produce an equal *momentum* (an equal useful effect, weight of wagons and engine included,) in the proportion of 1·42 to 1, or in a proportion something less than that of the velocities; to produce an equal *commercial* gross effect, (an equal useful effect, including the weight of the wagons,) in the proportion of 2·43 to 1, or nearly as the square of the velocities; to produce the same *useful* effect (the same useful effect, nett weight,) in the proportion of 3·11 to 1, or nearly as the cubes of the velocities.

This is the definitive result which Mr. Parkes has attained, and the help of which seems to him to render it needless henceforward to seek to determine either the friction of the wagons, or that of the engines, or the resistance of the air, or any thing in fact that may influence the effects produced; researches which appear to him to offer insurmountable difficulties. Possessed of the *wholesale* result of Mr. Parkes, nothing more will be needed. Does any one wish, for instance; to know what load a given engine will draw at 25 miles per hour, on a given inclination? to know what velocity it will assume with a load of 60 tons? to know what is the maximum of useful effect that it is capable of producing? to know what proportions must be given to it, in order to obtain desired effects? Why, having recourse to Mr. Parkes's result, the solution of all these questions is self-evident!

It is evident, on the contrary, that Mr. Parkes's result, even were it exact instead of being founded on erroneous calculation, could lead to but one thing, namely, to find the useful effect produced by an engine at the velocity of 30 miles per hour, when the same effect, in quite similar circumstances, is known at the velocity of 20 miles. But, even then, making use of so rough an approximation, in which

all is thrown in the lump: friction of the wagons, friction of the engine, resistance of the air, resistance owing to the blast-pipe, etc., the result could never be depended on. Assuredly, calculations like these do not tend to the progress of science; they would rather lead it back to its first rudiments. For this reason we persist in our belief that the only means of calculating locomotive engines, is to endeavor to determine, as exactly as possible, each of the resistances which oppose their motion, and by taking an account of the value of those forces in the calculation, we may then in every case attain a valuation really founded in principle, of the effects of every kind that are to be expected from them.

EARLY NOTICE OF THE NEW YORK AND ERIE RAILROAD.

The following article originally appeared February 22, 1828, only a few days subsequent to the death of the immortal Clinton. The communication was written by Mr. Boughten, of Virgil, and is worth preserving, as being the first *published* allusion, at least, to the New York and Erie railroad.

[From the Courtland Observer, February 22, 1828.]

The subject of internal improvement has been one of engrossing interest in this State, for several years past, and the facilities of conveyance have been greatly increased. The Grand Canal, extending from the Hudson to Erie, through the north part of this State, has proved of great advantage to the people at large; but the benefits derived from it have been realized, more particularly, in the parts adjoining it.

Still, in the winter season, farmers and others, who wish to transport property, have not the means in their power. This is true of those who reside near the canal; but the inconvenience is felt in the southern counties, to a great degree, in all seasons, as it is at a great expense that they ever take their surplus produce to the canal. Whenever this is done many embarrassments are experienced, which are not felt by those who live near the canal. To obviate these difficulties, and furnish the southern counties with a mode of transportation in many respects equivalent to the canal in the northern, a State road was projected to commence on the bank of the Hudson, and extend to Lake Erie, through the south part of the State; but after all that has been done, it is likely to fail. No communication has been provided to the Hudson, other than the northern and distant canal, and nothing is likely to be done towards the attainment of so desirable an object, unless some new suggestion should come before the public, that would excite attention and stimulate to persevering effort. The object of this communication is to enquire whether a railroad might not be constructed from some point either directly opposite or above New York, to Lake Erie, at or near the mouth of Cattaraugus creek. It is the opinion of your correspondent that a road of this discription may be formed between those places, on a tolerably direct route, without meeting any obstacle very difficult to be surmounted. I will now endeavor to present a general view

of the country, distances, etc. between those places, which may not be perfectly accurate, as it is not all derived from personal knowledge, and none from actual survey.

Let the road commence at some point opposite New York, and continue as nearly in the course to Milford, in Pennsylvania, as practicable. Probably the best route might be chosen along the Passaic or Saddle river, to near its source, from which it might continue over the ridge to Milford. From Milford, probably a northwest direction, or nearly to the forks of the Lackawaxen, and along one of its branches near Bethany to Mount Pleasant; from Mount Pleasant to the head of Sarucca creek, on the height of land between the Delaware and Susquehanna rivers; thence down said creek to the Susquehanna, at or near Harmony; thence to Binghampton and Owego. From Owego it would be most proper to proceed along the bank of the Susquehanna, till a convenient passage shall be found to the Chemung river, above Tioga Point; thence up the river to Post Town; thence to Hornersville, or higher up the Canisteo; thence on the best route to the head of the Cattaragus creek, and along said creek to Erie.

On reviewing the proposed route, it is thought that no great difficulty will present itself in the State of New Jersey. A height is, however, to be surmounted at or near Paterson, equal at least to the falls of the river. It appears from an examination of maps, that but one or two ridges of importance are to be passed. The greatest height, it is apprehended, may be easily overcome. The distance through New Jersey is about 70 miles. From Milford to the Susquehanna, a distance of about 80 miles, there is only one height of importance to pass, which is at the head of the Lackawaxen and Sarucca creeks. From Harmony to Binghampton, is a gentle descent; from Binghampton to Owego, from Owego to the Chemung river, and up the Chemung to Post Town, and along the Canisteo to Hornersville, a route may be selected with comparatively little ascent or descent. From Hornersville to the head of Cattaragus creek, there are doubtless some ridges of consequence; but from the head of the creek to the lake, we find no obstacle of importance, there being only a moderate descent along the creek.

It is not to be expected that a subject of this kind could be presented to the public, and made an object of concern, without some opposition, and many objections. Among others we may expect the following:

1. It will incur a great expense.

It is true that it will occasion considerable expense; but let the subject be examined a little. On the 14th of January last, a bill passed the Assembly to incorporate the Ithaca and Owego railroad company. The capital stock is to be $150,000; the distance is about 30 miles which would make the estimate $5,000 per mile. The distance of the road contemplated, is probably not far from 400 miles. At the above rate it would cost $2,000,000, which would not be one-third the expense of the canal. But suppose it should cost $4,000,000, which would probably be the expense of one that would be

permanent, it would then be only half the expense per mile of the canal.

2. The contempated road is to pass through several States.

To this it may be answered, that the distance between New York and Erie is less on this route than any other, and should it be constructed by this State alone, the expense would be proportionably less. But as it will be a great advantage to the other States, we may expect that they will do considerable towards its construction.

The Grand Canal has been completed at a great expense, and if there should be a railroad, much business would be taken from it, and thus render it unprofitable to the State.

In answer to this objection, it may be said that the canal has been finished but a short time, and the amount of business done on it now is very great. If it should increase for a very few years in the ratio that it has done, it would be exceedingly difficult to make much progress on it, in consequence of the great throng of boats, especially near the locks, and business would be thereby very much retarded.

Though the canal may have some advantages over a railroad, yet in many respects the latter would be superior. And first, property would not have to pass through so many agents, and thus many disappointments and mistakes would be prevented. 2d, by the use of the railroad, we might expect a more speedy conveyance of property. It has been stated that the force necessary to move a boat on the canal at the rate of $2\frac{1}{2}$ miles per hour, would move the same on a level rail at the same rate. In moving faster than this, the railway has the pre-eminence, and ascents and descents are much more easily passed on it than on the canal. The distance is much less by way of the contemplated road, from any place midway between it on the canal, than it is on the canal. 3d, the railroad furnishing means of transportation at all times, the markets would not be so fluctuating as at present, but would be more steady and regular, and thus much embarrassment and bankruptcy would be prevented. All parts of the State would then be enabled to send their produce to market and enjoy nearly an equal share of the facilities for transportation. Should this be effected, there would soon be communications from the canal to the railway, in different places. That contemplated from Ithaca to Owego would be one, and doubtless there would be others of great utility.

The resources of our country are great. In the State of New Jersey are rich beds of iron ore, and the country is generally fertile. In Pennsylvania there are extensive coal mines, and the population and wealth are fast increasing. This State is also fast increasing in wealth and population. But when we look farther, and see the fruitful and extensive country in the west, fast filling with inhabitants, it may safely be anticipated, that abundant use will be found for both a railroad and canal, and that their construction would be highly beneficial to this and other States.

[From the Civil Engineer and Architect's Journal.]

ELECTRO-MAGNETIC PRINTING.

On Monday, August 2d, the first public exhibition of Mr. Bains's electro-magnetic printing machine took place in the lecture room of the Royal Polytechnic Institution.

The apparatus consists of a dial-plate, inscribed with the alphabet and numerals, with a revolving hand, worked by ordinary clock-work. On the other side of the room stood the important portion of the invention—that which furnished in type the communication to be sent forth from the dial-plate already described. Between these two machines a connection (capable of being extended in practice to any length) by means of wire conductors communicating with two electro-magnets placed on a frame, and connected with a cylinder covered with paper, upon which the type was to leave its impression—an horizontal wheel, in which types to correspond with the letters and figures on the dial were fixed. This wheel was ingeniously brought in contact with an inking roller, and these three portions of the machine were all brought into motion horizontally.

The party directing the communication stands at the dial-plate first described, and fixes a peg under the letter desired to be communicated. The index or revolving hand performs its rotation until its progress is arrested by coming in contact with the peg. A small trigger is then pulled, the galvanic power is then brought to bear by the aid of the communicating wires upon the two electro-magnets, with their machinery on the second frame, and the letter thus communicated is printed upon the paper affixed to the cylinder.

The operations excited universal admiration, and the machine itself is well worthy the attention of the curious, for though at present it may fail as a speedy means of communicating information in print, still by the adoption of a code of signals (by which one letter or character might be construed to denote a sentence or describe a subject) the invention might be made extremely valuable in the times in which we live.

Electro-magnetic exhibition.—A very interesting exhibition has been lately opened at number 8, St. Andrew square, Edinburgh. It consists of several working models of different machines, such as a turning lathe, a printing machine, a saw mill and a locomotive carriage, driven by the power of electro-magnetism. The inventor of these models is Mr. Robert Davidson, an ingenious mechanic from Aberdeen, who has been engaged upon them for the last four years, and who has succeded in effecting several improvements in the application of electro-magnetism, which promise to be of great practical value. He is the first, we understand, who has employed the electro-magnetic power in producing motion, by simply suspending the magnetism without a change of poles. The mode employed by Jacobi Davenport and Storrar, consisted in keeping the repulsive power (which is equal to a third only of the attractive power) in operation during the one half of the time, and the attractive power during the other half. Mr. Davidson's discovery consists in a simple and extremely ingenious method of communicating

and cutting off alternately the galvanic current to and from a pair of electro-magnets that always act attractively, so as to exert a constant moving force upon the machine which is put in action. It has received the approbation of numerous scientific gentlemen, who consider that Mr. Davidson has succeeded in showing the perfect applicability of magnetism as a motive power to engines of every description. It would no doubt be desirable, however, to see experiments tried on a larger scale; which Mr. Davidson, we understand, is anxious to do, but is deterred by the want of funds.—*Scotsman.*

Travelling by electro-magnetic power.—We are informed that a distance of 57 miles has been travelled on the common road, in a Bath chair, by electro-magnetic power, in one hour and a half; and further, that the appiler comes over daily from St. Alban's to the bank of England in the said chair in half an hour at an expense of sixpence. The model of an electro-magnetic engine, which has been exhibiting at the Adelaide Gallery for some time, is an instance of ingenious mechanic arrangement, whereby contact is broken and renewed, the poles reversed, etc.; and from its performances gave great promise of practical powers on a larger scale. The battery employed is the nitric acid, or Grove's battery. Of the invention that has done the great feat, and established the successful application of this wonderful agent, we know little more than its success. We hear that the increase of power is due to the discovery of a new combination of elements; that this is the secret of the moving power; and that the battery is to be the subject of a patent.—*Literary Gazette.*

[Extracts from "Brief Facts in relation to the New York and Erie railroad"]

WESTERN RAILROAD OF MASSACHUSETTS.

This railroad, constucted by the funds raised by the citizens of Boston, and those of the State along the line of the road, also by a State loan of about $4,000,000, extends from Worcester to West Stockbridge 117 miles, connecting on the east with the Boston and Worcester railroad, 44½ miles long; and on the west, with the Albany and West Stockbridge railroad, 38½ miles in length; making 200 miles from Boston to Albany, in the hands of these joint stock companies. The following, from the Boston Atlas, since the completion of the railroad, shows the calculations of the Bostonians on the revenue for this year, of the Western railroad alone, 117 miles in length, which is but little more than one fourth of the length of the New York and Erie railroad.

Revenue of the Western railroad.—An intelligent friend, and one who is well acquainted with the subject, has furnished us with the following document, showing the probable income of this magnificent public work:—

Estimated nett revenue of the Western railroad for the year 1842, in case said railroad has a sufficiency of cars and locomotives.

Nett amount, after deducting toll to the Boston and Worcester railroad, and after deducting all other expenses:

100,000 bbls. flour for the Connecticut valley.
100,000 " " Trade centering at Worcester.
20,000 " " west of Chester.
780,000 " " Boston.

1,000,000 barrels at 15 cents per barrel,
Nett profit on an everage - - - $150,000
300,000 through passengers, being 500 each way, per day,
at $1,50 each, nett profit, - - - 450,000
Way passengers will probably equal, in profit, the through
passengers: but say one half as much, nett - 225,000
50,000 hides to Green county, say - 625 tons
100,000 sides leather, back - - 937½ "
50,000 hides to other places at or near the road 625 "
100,000 sides leather, back - - 937½ "

At $2 per ton, nett profit on - 3125 tons 6,250
100,000 hogs, dead and alive, or in barrels at 50 cents each,
nett profit - - - - 50,000
20,000 head of cattle, dead or alive, or in barrels at $1,25
each, nett profit - - - - 25,000
100,000 tons merchandize up, through freight at $2 per
ton, nett profit - - - - 200,000
50,000 tons way freight, of articles not enumerated, at $1
per ton nett profit - - - 50,000
2000 tons wool at $3 per ton, nett profit - - 6,000
10,000 bales cotton at 50 cents per bale, nett profit - 5,000
6,250 tons salt at $1 per ton, nett profit - - 6,250
30,000 tons boards and scantling, shingles, timber, staves
and other wood, at $1 per ton nett profit - 30,000
40,000 tons pig iron, marble free stone, grindstones, plaister
paris, mica slate, lime, and other stones, at $1 per
ton, nett profit - - - - - 40,000
1,000 tons fur and peltry at $3 per ton, nett profit - 3,000
4,000 tons pot and pearl ashes at $2 per ton, nett profit 8,000
5,000 tons cheese at $3 per ton, nett profit - 15,000
3,000 tons butter and lard at $3 per ton, nett profit - 9,000
10,000 tons coal at $1 per ton, nett profit - - 10,000
20,000 tons wheat at $1 per ton, nett profit - - 20,000
10,000 tons rye, corn, barley, and other grains, at $1 per
ton, nett profit - - - - 10,000
5,000 tons bran and ship stuffs, peas, beans, potatoes, at
$1 per ton, nett profit - - - - 5,000
500 tons clover and grass seed, flax seed, and hops, at $3
per ton, nett profit - - - - 1,500
3000 tons furniture, at $3 per ton, nett profit - 9,000
2,000 tons iron ware, at $1 per ton, nett profit - 2,000
5,000 tons wooden ware, at $1 per ton, nett profit - 5,000

Estimated nett revenue of the Western railroad, for
the year 1842 - - - - $1,341,000
which on its cost, $6,700,000, is 20 per cent. per annum.

This document has been prepared with very great care. Any one who will examine the detail of the trade on the Erie canal, during 1839 and 1840, (table 2 and other tables of Senate Documents No. 63 and 65 of New York Legislature for 1840 and 1841,) and will reflect on the fact that Massachusetts is the best market to sell a great amount of the products which come from the canal, and is also the best market to buy the goods wanted in return;—any one who will reflect that the west produces, almost spontaneously, what we want, and desires to buy our manufactures, our fisheries, and our imports; any one looks at the authentic fact that 3000 passengers go daily between New York city and Albany during eight months of the year, and who farther reflects that western New York and the whole west is full of Yankees, who desire to visit their kindred, and have their visits returned; any one, who reflects that the amount paid for freight and passage on the Erie canal, and on the railroads parellel to it, exceeds $5,000,000 annually, and who also looks at the fact, that the Western railroad is a continuation of said railroad; any one who takes up the present document, item by item, and after investigation, set down his own conclusions, and then foots up those conclusions—will come to a result, the magnitude of which may astonish him, and yet fall far short of sober reality.

Is it not then perfectly natural that the Western railroad, like the Grand Junction, the London and Birmingham, and other long lines of railroads in Great Britain—and like the Erie canal and the long lines of railroads along side of it,—should, by the magnitude of its nett revenue, astonish even the most sanguine?

INSANE PROJECTS.

When Columbus determined on the vast enterprise of seeking a new world, the courts of Genoa, Portugal, and for several years, that of Spain, looked upon him as a visionary mendicant. But he sailed upon his voyage, discovered America, and his tomb-stone bears the proud record, "*A Castilla ya Leon, Neu vo Mundo Dio Colon.*" To Castile and Leon, Columbus gave a New World.

When Fulton started his first steamboat, "Clermont," on the Hudson, he said that people shook their heads, and said that it was the project of a crazy man; he accomplished his scheme and a thousand steamboats attest his praise.

When the steamship Savannah, sailing from this port crossed the Atlantic, and became the *first* steamer that ever touched the shores of both hemispheres, it was declared that it could not be done again, and that it was madness to try. The many steam-moved packets that now cross and re-cross, show the *insanity* of the project of Atlantic steam navigation.

When De Witt Clinton struck out in conjunction with an humble engineer, the grand plan of connecting the great lakes of the north, with the waters of the seaboard, he was ridiculed as a fanciful theorist, who had lost the balance wheel of his judgment. The Erie canal was however completed, and the mere tolls of the last year

amounted to *two millions and thirty thousand dollars*, sufficient to pay off the entire interest of the State debt of twenty millions, and leave a surplus of over a million for incidental expenditures, to say nothing of the incalculable benefit this work has been to western New York, and the western States.

When the plan was first proposed of uniting the city of Boston, with the pier heads of St. Louis in Missouri, it was laughed at as the absurdity of a dreamer; and when General Dearborn spoke of tunnelling the Housatanic mountain, to get to Albany, they thought him almost qualified for a cell in the McLean Asylum. But the mountains have been crossed, Albany has been reached, it is even now a day nearer Europe in point of time than New York; the line of steam communication which shall unite the valley of the west, with the waters of the Atlantic, is fast being completed, will soon bind them in irrefragable alliance. These are but a few specimens of the projects which in their incipiency men have pronounced insane, and held up to derision. So will it ever be, with those, who lead on in advance of human progress, they are ridiculed as enthusiasts, regarded with distrust, taunted with madness. The rewards of genius lie in the future; the generation which surrounds such men seldom appreciate or understand their value, and yet, but for these men, who throw themselves forward into coming ages, and disclose the vista of human improvement, society would stand still, or revolve like that of China, in a perpetual circle without advancing in arts, in knowledge, in goverment, or religion, speculation produces theory—theory, experiment—experiment, result; and these results giving impetus to mind, carry forward society to the threshold of new projects, which in turn are denounced as visionary and insane, which in turn are verified, which in turn are soon looked back upon, as old and established truths; in the reaching forward of man, after still newer schemes, and still bolder designs. Who shall set limitations to the devices of an illimitable mind.—*Georgian.*

NEW LOCOMOTIVE ENGINE.

I have examined with much pleasure another important improvement in the locomotive engine, by our ingenious and enterprising townsman, M. W. Baldwin, Esq. This improvement consists in an attachment of power to all the wheels, six in number, in such a way as to obtain the adhesion of the whole weight of the engine to propel the load, while all the advantages of a vibrating truck under the front end of the engine in accommodating the curves and undulations of the road, are preserved, as in Mr. Baldwin's ordinary six wheeled engine, in which only two of the wheels are used to propel the load. This advantage is highly valuable and important, and will be readily appreciated by managers and engineers who are familiar with locomotives, and the difficulties heretofore experienced in overcoming high grades, from a want of adhesion in a light engine. The hindmost wheels of the engine (two in number,) are 44 inches in diameter, and the forward or guide wheels attached to a vibrating truck (four in number) are 33 inches in diameter. The

hindmost driving wheels carry (including their own weight,) 11,775 lbs, and the front wheels carry, including their own weight, 13,225 lbs. Total weight of engine, with water and fuel, 30,000 pounds, or 13 tons, 7 cwt. 3 qrs. and 12 lbs.

This engine has been performing for a few days on the Columbia railroad, between the bridge and the city, in making experiments, which have resulted highly satisfactory to Mr. Baldwin, and a number of scientific gentlemen who have attended several of them. No opportunity has occurred yet for an experiment with a sufficient number of cars to prove the full power of the engine. Yesterday, the 25th inst. she drew from the bridge to the city a train of seventy-three loaded cars, being the Reading freight train; weight of merchandise, 200 tons, weight of cars, 130 tons, making a total gross load of three hundred and thirty tons, exclusive of the weight of engine and tender. This performance was upon a portion of the road having numerous curves and grades, the latter rising 30 feet per mile in the direction the train was moving. The engine passes with ease round a curve of 90 degrees, upon a radius of 312 feet. After the engine was detached from the train she was run round a curve of 90 degrees upon a radius of only 75 feet, without extraordinary friction.

This improvement will no doubt be duly appreciated by the railroad community, and will add to the present high character of its talented projector. All who feel interested should take an early opportunity to examine this engine, as it will be removed to the Reading railroad in a few days. C. E.

[*United States Gazette.*

Edinburgh and Glasgow Railway.—It is gratifying to observe the incessant exertions which are making every where on the line in the vicinity of this city to get this national undertaking completed. The magnificent entrance to our great tunnel is drawing to a conclusion, while the booking and other offices are all but finished. The landing and departing platforms are now getting very handsome sheds, with elegant cast iron supports set up; and the ground is clearing out for laying the permanent rails. Yesterday, Mr. John Craig, the mineralogist, made a survey of the tunnel, in furtherance of the objects of the British Association, and proceeded right through it, in company with the very polite and spirited contractor, Mr. Marshall. Amongst many other geological specimens got in the journey, we saw perfect masses of the *Nucula Tumida*, *Producta Scotia*, *Producta Martinnii*, *Bellerophon Urii*, and *Apiocrinites*, imbedded in a shale, above a two feet limestone, with many other interesting remains of a period long before the creation of man.—*Glasgow Constitutional.*

Cheltenham and Great Western Union Railway.—Contracts have been taken, and in some instances the works have been commenced, for carrying on this line from its present terminus at Cirencester towards Stroud and Gloucester.—*Cheltenham Looker-on.*